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Monthly report of progress in developing an enhanced self priming topcoat using high performance urethane resins and advanced concepts in nonchromate corrosion protection. The goal of the program is to develop a coating that meets and exceeds the requirements of TT-P-2756 and exceeds the performance of the existing topcoat material qualified to the specification.

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Development of an Enhanced Durability Corrosion
Protecting Self-Priming Topcoat
Contract No. N00014-02-C-0108

R&D Status Report #24

Reporting Period: June 7, 2004 through July 6, 2004

Summary of Current Progress

- Weatherability and corrosion testing of 13% and 20% hydrotalcite formulations is complete
- Weathered panels for cleanability studies have been characterized
- Summary of data to support formulation downselect is being compiled

Phase I – Formulation Trade Studies is complete. Promising inhibitor systems have been identified for optimization in Phase II.

Phase III – Flight Test is scheduled to start in 2005.

Phase II – Optimization

Round One

Corrosion Ranking

Corrosion testing has been completed for all Round One optimization formulations. The ranking results from 3000 hours of exposure to neutral salt fog are shown in Table 1 for AA2024-T3 substrates and Table 2 for AA7075-T6 substrates. These data are ranking of the panels against one another. Panels that had been stripped of the coatings were used to make the ranking. Evidence of under film corrosion and other defects are more easily seen with the stripped panels.

Several trends are apparent in these data:

- Overall, the higher loadings of inhibitor provided better corrosion resistance. This trend is seen with all of the inhibitors and for both substrates
- Hybricor 204 and the hydrotalcites outperform the standard inhibitors used in the present TT-P-2756 coating
- Conductive inorganic pigments have a detrimental effect on corrosion protection
- The coatings using the standard inhibitors in the fluorourethane resin system outperform the control TT-P-2756 coating
- The two alloys show a different ranking but follow the same trends. A statistically valid sample is needed to highlight any specific alloy sensitivities.

Table 1 -- Corrosion Ranking of Coatings on AA2024-T3

Formulation #	Inhibitor	Rank
97GY133	13% Hydrotalcite -- 25.3% PVC	1
97GY107	Hybricor 204 -- 25.3% PVC	2
97GY109	Standard Inhibitors + Hybricor 204 -- 25.3% PVC	3
97GY120	Standard Inhibitors + conductive pigments -- 22.0% PVC	4
97GY114	Hybricor 204 -- 22.0% PVC	5
97GY113	Hybricor 204 -- 14.6% PVC	6
97GY138	20% Hydrotalcite -- 25.3% PVC	7
97GY136	20% Hydrotalcite -- 18.5% PVC	8
97GY129	13% Hydrotalcite -- 18.5% PVC	9
97GY116	Standard Inhibitors + Hybricor 204 -- 22.0% PVC	10
97GY102	Standard Inhibitors -- 25.3% PVC	11
97GY118	Standard Inhibitors + conductive pigments -- 25.3% PVC	12
97GY112	Standard Inhibitors -- 22.0% PVC	13
97GY140	20% Hydrotalcite -- 22.0% PVC	14
97GY115	Standard Inhibitors + Hybricor 204 -- 14.6% PVC	15
97GY111	Standard Inhibitors -- 14.6% PVC	16
97GY105	Standard Inhibitors -- 10.4% PVC	17
03GY369	Control	18
97GY134	13% Hydrotalcite -- 14.6% PVC	19
97GY135	13% Hydrotalcite -- 22.0% PVC	20
99GY041E	Standard Inhibitors -- 18.5% PVC	21
97GY132	13% Hydrotalcite -- 10.4% PVC	22
97GY139	20% Hydrotalcite -- 14.6% PVC	23
97GY096	Standard Inhibitors + Hybricor 204 -- 18.5% PVC	24
03GY369	Control	25
97GY086	Standard Inhibitors + conductive pigments -- 18.5% PVC	26
97GY106	Hybricor 204 -- 10.4% PVC	27
97GY108	Standard Inhibitors + Hybricor 204 -- 10.4% PVC	28
99GY044E	Hybricor 204, 18.5% PVC	29
03GY369	Control	30
97GY137	20% Hydrotalcite -- 10.4% PVC	31
97GY119	Standard Inhibitors + conductive pigments -- 14.6% PVC	32
97GY117	Standard Inhibitors + conductive pigments -- 10.4% PVC	33

Table 2-- Corrosion Ranking of Coatings on AA7075-T6

Formulation #	Inhibitor	Rank
97GY135	13% Hydrotalcite -- 22.0% PVC	1
97GY140	20% Hydrotalcite -- 22.0% PVC	2
97GY133	13% Hydrotalcite -- 25.3% PVC	3
97GY138	20% Hydrotalcite -- 25.3% PVC	4
97GY129	13% Hydrotalcite -- 18.5% PVC	5
97GY139	20% Hydrotalcite -- 14.6% PVC	6
97GY136	20% Hydrotalcite -- 18.5% PVC	7
97GY137	20% Hydrotalcite -- 10.4% PVC	8
03GY369	Control	9
97GY134	13% Hydrotalcite -- 14.6% PVC	10
97GY132	13% Hydrotalcite -- 10.4% PVC	11
03GY369	Control	12

Weatherability Rating

Weathering testing is complete for all Round One optimization formulations. The data for the hybrid coatings are shown in Table 3 and are graphed in Figure 1. There is a general trend toward increasing Delta E as the inhibitor loading increases. Weathering of these coatings is remarkably better than the controls. Increasing the amount of organic inhibitor in the hydrotalcite has a negative effect on Delta E.

Table 3 -- 2000 Hours Xenon arc accelerated weathering

	13% HT	20% HT	Hybricor 204
10.4 PVC	1.21	1.2	0.9
14.6 PVC	1.06	2.4	1.1
18.5 PVC	1.31	2.7	1.3
22.0 PVC	1.43	2.1	1.6
25.3 PVC	1.65	2.9	1.8
Control	7.65	7.1	6.2

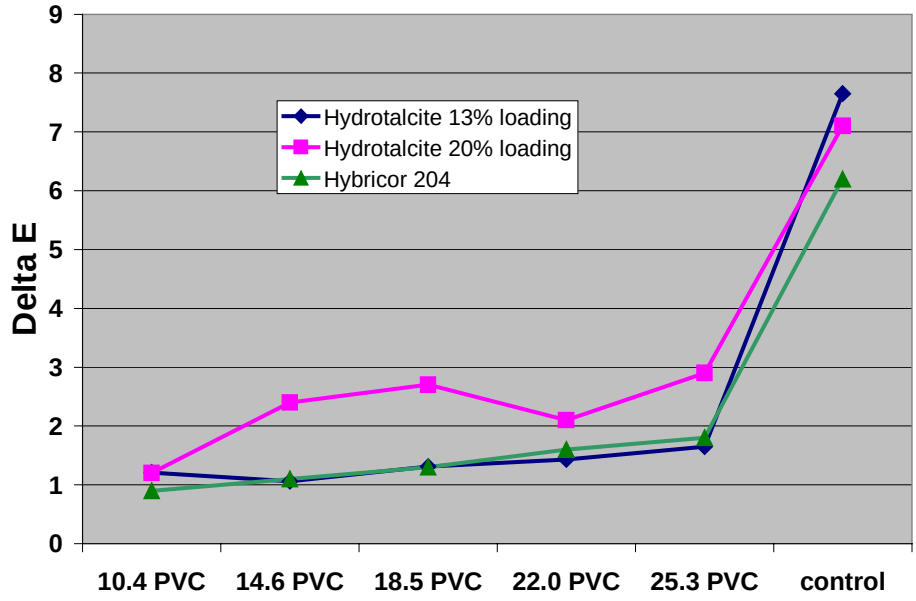


Figure 1 – Weathering results (2000 hour Xenon Arc)

Cleaning Methods

Panels weathered for 500 hours in a UVCon cabinet have been characterized by SEM and EDX prior to cleanability testing. The data for 99GY044E (Fluorourethane resin with Hybricor 204) and 97GY086 (Fluorourethane resin with standard inhibitors and conductive pigments) are shown in Figure 2 and Figure 3. The surfaces seem quite smooth after only 500 hours of weathering. The EDX data show characteristic peaks of the pigmentation. Changes to the EDX signature and surface profile will be noted after cleanability studies.

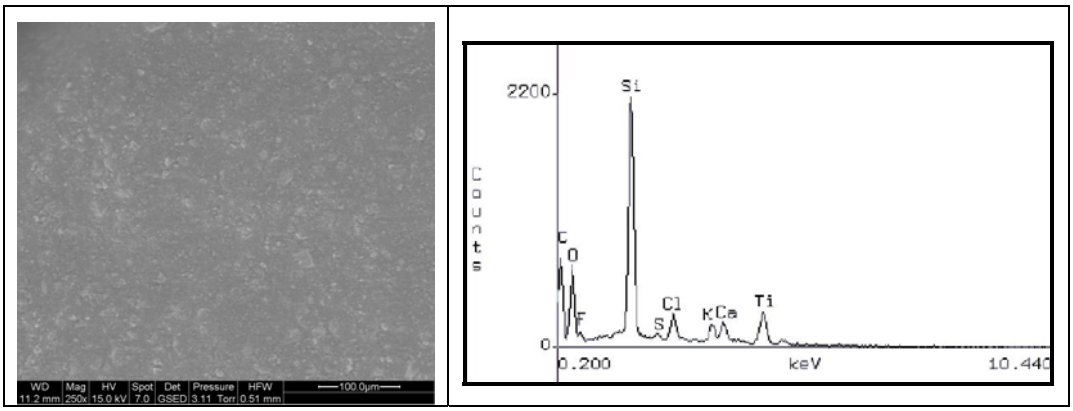


Figure 2 -- SEM and EDX Data for 97GY086 Coating

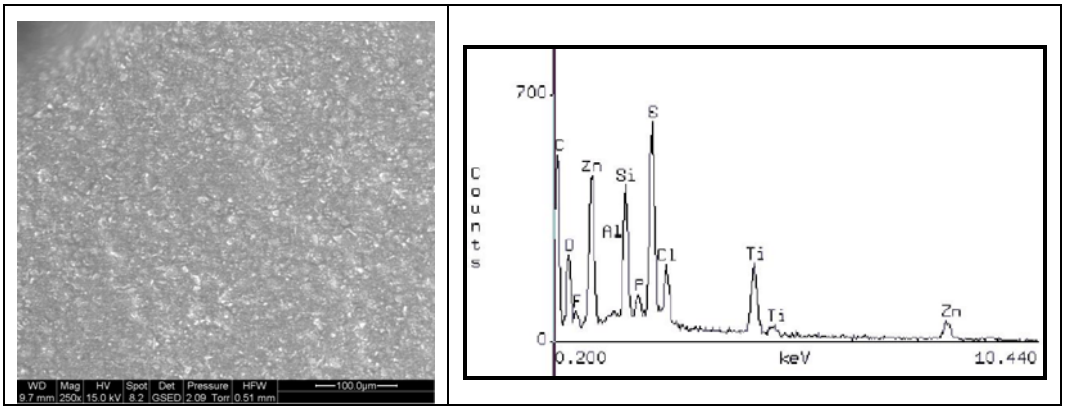


Figure 3 -- SEM and EDX Data for 99GY044E Coating

Downselect Criteria

A summation of all of the results from the ladder studies is being compiled. These data will be used to select inhibitor formulations and concentration levels for final optimization studies. Selection of formulations to optimize for storage stability, pot life, cleanability, etc., will be a compromise between weatherability and corrosion protection. In almost all cases increasing inhibitor concentration increases corrosion protection but decreases weatherability as determined by delta-E measurements.

Considering all of the data, the Wayne Hybricor 204 and the 13% hydrotalcite inhibitor formulations appear to have the best overall properties. This preliminary downselect will be refined next month when all of the data is available. A review of the panels by the team is being discussed. Considering other commitments, a face-to-face meeting is not likely until mid-July. Finalizing the downselected materials is desired as early as possible to facilitate formulation and testing of the next round of materials.

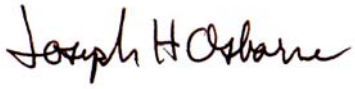
Plans For Next Month

- Downselect formulations for optimization of performance and application properties
- Start cleaning methods testing
- Present an overview of program progress at the annual FNC-TOC Program Review.

Task Schedule: -- See Attached. Program is on schedule.

Cost Summary: -- Sent under separate cover.

Prepared by:



Joseph H. Osborne
Principal Investigator

Program Schedule – June 2002 through July 2006